DARPA AND THE INFORMATION AGE

Agency Activities in Information Technology Have Helped to Create Today's IT Experience

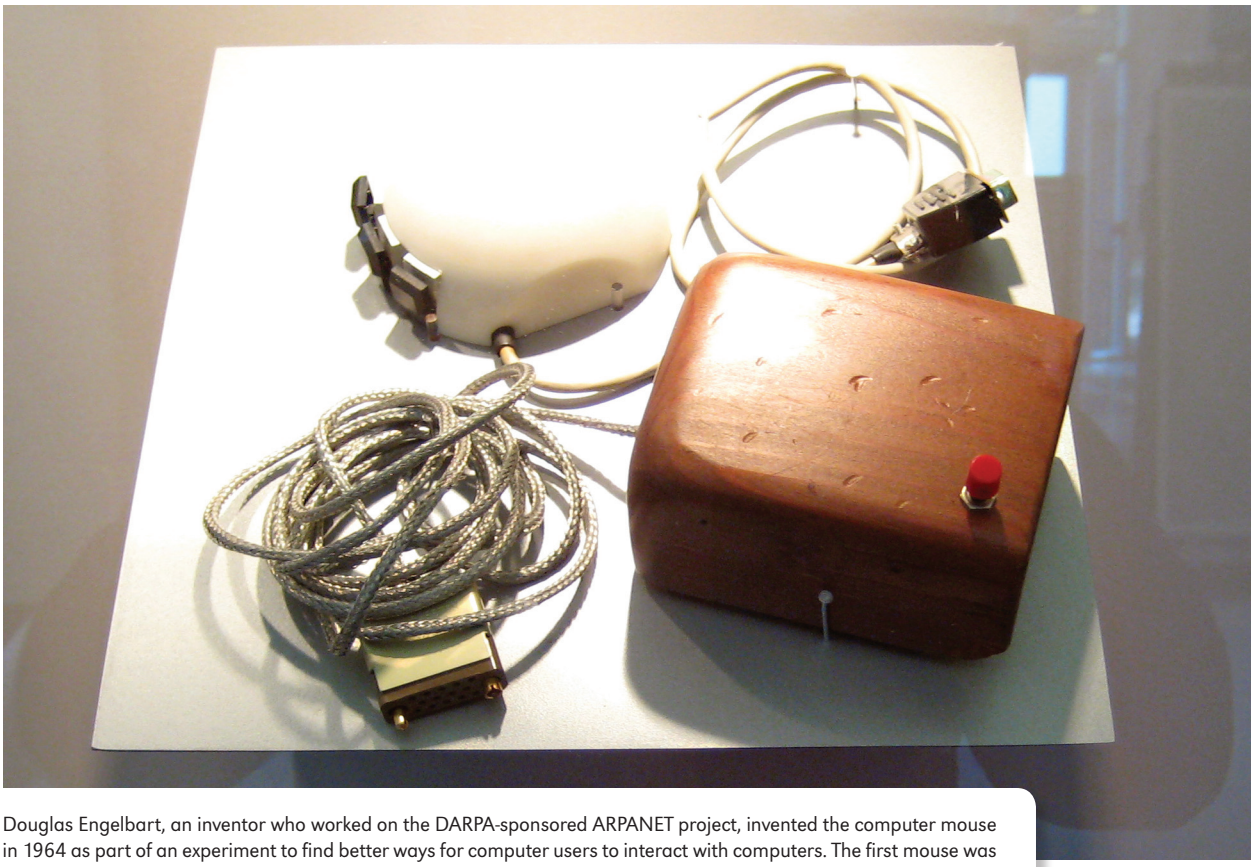
By Henry S. Kenyon

Information technology (IT) has been at the forefront of technological change for the last 50 years. Computers are now pervasive in society and have brought radical changes to the way we work, the way we conduct business, and the ways we socialize. The Internet and the World Wide Web, Internet search, instant messaging, blogs, e-commerce, network-enabled media delivery, and the like, also enabled by computers and networks, continue to impress with their novelty, speed of adoption, and promise. Computing has revolutionized warfighting as well, bringing vast improvements in weapons, platforms, command and control, battlefield intelligence, and logistics.

DARPA has been at the forefront of information technology for that same 50 years. The Internet is perhaps DARPA's most publicized accomplishment, but DARPA investments in computing and IT over the years have also yielded many other important achievements. In *What Will Be* (HarperCollins, 1997), Michael Dertouzos credits DARPA with "... between a third and a half of all the major innovations in computer science and technology."

Over the past 50 years, DARPA has had a major role in the creation of fundamental computer and information technology, including hardware, software, and networking. On the hardware side, such varied and disparate technologies as reduced instruction set computing, the computer "mouse," very large-scale integration microprocessors technology, and parallel computing systems all either originated or were given a very significant boost by DARPA-sponsored research and development. Likewise, DARPA's direct and indirect contributions to software include trend-setting operating systems like Multics, a wide variety of parallel language techniques, distributed computing, computer graphics technologies, and computer vision and artificial intelligence efforts. And, of course, we have the Internet and a host of associated advances derived from the packet-switching concept. Arguably, this certainly belongs in the list of "Top N" revolutionary technological advances for humankind. An article on the early origins of the ARPANET, as it was called at the time, appears in this magazine.

Another area with tremendous potential impact is cognitive computing, the development of computer techniques to emulate human perception, intelligence, and problem-solving for both fundamental scientific understanding and for advanced military and non-military applications. DARPA's early support of artificial intelligence essentially launched the field and, more recently, cognitive computing has received new attention. The motivation for the fresh look has been twofold. First, the growing complexity of military missions has led to new levels of uncertainty and complexity in the decision-making, management, and understanding of warfighting. This in turn has led



Douglas Engelbart, an inventor who worked on the DARPA-sponsored ARPANET project, invented the computer mouse in 1964 as part of an experiment to find better ways for computer users to interact with computers. The first mouse was carved out of wood and had just one button. Later incarnations such as this early Logitech® mouse led to the diversity of mice now on desktops around the world.

Photo courtesy of the Computer History Museum

to ever-growing manpower requirements for IT operations and support. Second, the increasing complexity, rigidity, fragility, and vulnerability of computer systems has tended to counteract and even out-distance the increased raw performance of computers themselves.

DARPA has started a number of new programs in cognitive computing, many with an emphasis on learning. There are several goals here. First, computers should have an understanding of what the user is really trying to do and provide proactive intelligence assistance and advice. Second, many of the challenges faced by military commanders involve vast amounts of data from sensors, reports, databases, the Web, and humans. What is needed are computing systems that can learn and reason to structure massive amounts of raw data into useful, organized knowledge with a minimum of human assistance and adapt to new situations. Third, computer systems and applications are notoriously difficult to understand and maintain. One vision is to develop the science and engineering of cognition sufficiently so that IT devices and applications of all types will be less fragile and more robust. DARPA is working hard on this vision.

While the Internet is perhaps DARPA's biggest legacy impact and cognitive computing is one intriguing approach for the future of information technology, DARPA is aggressively pursuing a panoply of other high-risk approaches as well. The following articles describe three of these efforts. First, High-Productivity Computing Systems (HPCS) is tackling the combined problem of next-generation parallel computer hardware systems along with the software (operating systems, libraries, applications, and development tools) needed to use them effectively. HPCS's goal is vastly more productive applications to enable rapid testing and iterative development of new ideas. If the ambitious project is successful, HPCS will give the United States a competitive edge over other nations in the time it takes to bring a new concept into a new technical capability. Second, language translation is an urgent strategic need to enable effective global operations. There are a number of efforts under way in DARPA and they are discussed in this book. Third, quantum information science is seeking insights into the non-intuitive behavior at the subatomic level of physics. If this can be properly understood scientifically, revolutionary new applications to computing, IT, and secure communications could be realized.

These are but a few of the many exciting and promising projects DARPA is executing in the field of IT, with many more planned and others not yet imagined. The needs and challenges are great, but with DARPA's track record in the area, we can be sure of more exciting changes for the field.